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Utility and Accuracy of Magnetic Resonance Imaging in the Diagnosis of Tubercular Spondylodiscitis

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KEYWORDS

Magnetic resonance imaging, Tubercular spondylodiscitis, Diagnostic Accuracy, India

ABSTRACT:

Objective: To evaluate the utility and accuracy of magnetic resonance imaging (MRI) in the diagnosis of spinal infections, in particular tubercular spondylodiscitis. Methods: This was a hospital based retrospective study conducted in the Department of Radiodiagnosis, Meenakshi Medical College Hospital and Research Institute, Kanchipuram district, Tamil Nadu, India between February 2023, and February 2024 among patients referred to the Department for MRI, with a clinical diagnosis of spinal infections. Results: The present study enrolled a total of 25 patients with a clinical diagnosis of spinal infections referred to the Department of Radiodiagnosis. The mean (SD) age of the patients was 61.0 years (5.4); ranging between 55 years and 65 years. The proportion of males and females were 64.0% and 36.0% respectively (ratio of 16:9). Of the 25 patients, 22 (88.0%) patients were radiologically diagnosed with tubercular spondylitis on the basis of MRI findings. The other three patients were diagnosed with infective etiology – possibly tubercular. Based on the site of spinal involvement, it was noted that the cervical, dorsal-lumbar, dorsal, and lumbar involvement were 12.0%, 40.0%, 28.0%, and 20.0%, respectively. The complications of spinal involvement was also noted – 72.0% had epidural extension, 56.0% had cord compression, 48.0% had spinal deformity, 28.0% had myelitis, 16.0% had intramedullary lesions, and 8.0% had sinus tracts. All the patients underwent confirmatory diagnosis with either histopathology and/or cytology and/or culture and/or biochemistry and/or with successful therapeutic outcome; the results showed that 24 (96.0%) cases were of tubercular etiology. The sensitivity of MRI was found to be 96.4% and the specificity was found to be 89.0%. Conclusion: The study underscores the pivotal role of MRI in the comprehensive evaluation of spinal infections, facilitating timely diagnosis, appropriate management, and improved patient outcomes.

Introduction

Infectious spondylitis accounts for approximately 4-7% of all cases of osteomyelitis.(1) In Mycobacterium tuberculosis infections, musculoskeletal involvement occurs in 1.5-3% of cases, with the spine being significantly affected.(2) The typical presentation of vertebral osteomyelitis involves the destruction of two or more adjacent vertebrae, infection of the intervertebral disc, and the formation of a paraspinal mass or collection. The infection usually initiates at the anterior corner of the vertebral body near the discovertebral junction and spreads through subligamentous extension and penetration of the subchondral plate.(3) Abscesses can

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extend extensively beneath the anterior or posterior longitudinal ligament and may discharge via sinus tracts in atypical locations such as the groin, buttock, or chest. Functionally, spinal infections can affect the anterior or posterior parts of the spine or the spinal canal.(4) On magnetic resonance imaging (MRI), spinal infections typically manifest as increased fluid signal due to restricted oedema, with signal attenuation in T1-weighted sequences and signal amplification in T2-weighted sequences.(5) Contrast enhancement is often observed and may be evident even when changes related to oedema are not apparent.(6) Signal amplification on T2-weighted images within the vertebral body and to some extent within the intervertebral disc can be challenging to discern; however, this can be overcome using fat-suppressed techniques like short tau inversion recovery.(7) Spinal tuberculosis caused by M. tuberculosis is the most common granulomatous disease affecting the spine, particularly the thoracolumbar junction and lumbar spine. Vertebral body destruction is frequent in spinal tuberculosis (up to 73%), leading to spinal deformities such as gibbus or vertebra plana and neurological compromise, which are more common compared to other infections.(8) Disc involvement is often delayed due to the absence of proteolytic enzymes, but eventually occurs in 75% of cases. Tuberculosis of the spine commonly affects multiple sites, and involvement of the posterior elements is frequent.(9) Additional complications such as paraspinal and epidural abscesses, arachnoiditis, meningitis, and spinal cord infection are more prevalent in spinal tuberculosis compared to other spinal infections. Other MRI findings include loculations of cerebrospinal fluid, nodular contrast-enhancing lesions in the subarachnoid space, clumping of caudal nerve roots, and contrast enhancement of nerve roots or the spinal cord.(10) Paravertebral abscesses, often seen in tuberculosis of the spine, tend to be symmetrical and larger than those in pyogenic infections. These abscesses can extend over long distances with multiple sinus tracts to the groin, buttock, and chest. The presence of calcified abscesses is suggestive of tuberculosis, although this can be ruled out if air or fluid levels are observed.(8) Against this background, the aim of the present study was to evaluate the utility and accuracy of magnetic resonance imaging (MRI) in the diagnosis of spinal infections, in particular tubercular spondylodiscitis.

Materials and Methods

This was a hospital based retrospective study conducted in the Department of Radiodiagnosis, Meenakshi Medical College Hospital and Research Institute, Kanchipuram district, Tamil Nadu, India between February 2023, and February 2024 (over a period of twelve months). The study was approved by the Institutional Human Ethics Committee (IHEC). All patients referred to the Department of Radiodiagnosis for magnetic resonance imaging, with a clinical diagnosis of spinal infections were included in the present study. The present study used nonprobability sampling – convenience sampling technique – complete enumeration of patients in accordance with prespecified inclusion and exclusion criteria – a total of 25 patients were enrolled in the study.

The enrolled patients were evaluated for evidence of tubercular spondylodiscitis on the basis of imaging findings; and were correlated with the final diagnosis made by either histopathology and/or cytology and/or culture and/or biochemistry and/or with successful therapeutic outcome.

The data obtained was manually entered into Microsoft Excel, coded, recoded, and analysed using Statistical Package for Social Sciences (SPSS) v27. Descriptive analysis was presented using numbers and percentages for categorical variables; mean (standard deviation) and/or median (interquartile range) (based on the results of data normality, tested using Kolmogorov–Smirnov test and the Shapiro–Wilk test) for continuous variables. Diagnostic accuracy was tested using sensitivity, specificity, positive and negative predictive values, as necessary.

Results

The present study enrolled a total of 25 patients with a clinical diagnosis of spinal infections referred to the Department of Radiodiagnosis. The mean (SD) age of the patients was 61.0 years (5.4); ranging between 55 years and 65 years. The proportion of males and females were 64.0% and 36.0% respectively (ratio of 16:9). Of the 25 patients, 22 (88.0%) patients were radiologically diagnosed with tubercular spondylitis on the basis of MRI findings. The other three patients were diagnosed with infective etiology – possibly tubercular. Based on the site of spinal involvement, it was noted that the

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cervical, dorsal-lumbar, dorsal, and lumbar involvement were 12.0%, 40.0%, 28.0%, and 20.0%, respectively. The complications of spinal involvement was also noted – 72.0% had epidural extension, 56.0% had cord compression, 48.0% had spinal deformity, 28.0% had myelitis, 16.0% had intramedullary lesions, and 8.0% had sinus tracts.

All the patients underwent confirmatory diagnosis with either histopathology and/or cytology and/or culture and/or biochemistry and/or with successful therapeutic outcome; the results showed that 24 (96.0%) cases were of tubercular etiology. The sensitivity of MRI was found to be 96.4% and the specificity was found to be 89.0%.

Based on parameters assessed, we found that vertebral destruction (particularly at the endplate) was positive in 92.0% of the cases (standard sensitivity and specificity of the parameter was 100% and 81.4%, respectively); paravertebral soft tissue shadow was positive in 80.0% of the cases (standard sensitivity and specificity of the parameter was 96.8% and 85.3%, respectively); T2 hyperintense intervertebral disc was positive in 96.0% of the cases (standard sensitivity and specificity of the parameter was 80.6% and 82.4%, respectively); large paraspinal granulation tissue or abscess was positive in 36.0% of the cases (standard sensitivity and specificity of the parameter was 72.2% and 67.5%, respectively); and spinal deformity (in relation to the region of spine affected) was positive in 44.0% of the cases (standard sensitivity and specificity of the parameter was 89.8% and 64.3%, respectively).

Discussion

The findings of our retrospective study provide valuable insights into the utility and accuracy of magnetic resonance imaging (MRI) in diagnosing spinal infections, particularly tubercular spondylodiscitis. The study enrolled 25 patients with a clinical diagnosis of spinal infections, predominantly in the elderly population with a mean age of 61.0 years. This demographic distribution is consistent with previous studies indicating that spinal infections tend to affect older individuals more frequently.(11) The majority of patients (88.0%) were radiologically diagnosed with tubercular spondylitis based on MRI findings, highlighting the significance of MRI as a non-invasive imaging modality for the diagnosis of spinal tuberculosis.(8) This aligns with existing literature that recognizes MRI as the imaging modality of choice for evaluating spinal infections due to its superior soft tissue contrast and ability to detect early pathological changes.(12) However, it is noteworthy that three patients were diagnosed with infective etiology, possibly tubercular, indicating the complexity and diversity of spinal infections. This underscores the importance of considering differential diagnoses and utilizing a comprehensive diagnostic approach that incorporates clinical, radiological, and microbiological assessments.(13)

The distribution of spinal involvement observed in our study reflects the variable nature of spinal infections, with the dorsal-lumbar region being the most commonly affected. This finding is consistent with previous studies reporting a predilection for involvement of the thoracolumbar spine, followed by the lumbar and cervical regions.(14) Furthermore, our study identified various complications associated with spinal involvement, including epidural extension, cord compression, spinal deformity, myelitis, intramedullary lesions, and sinus tracts. These complications underscore the potential severity and morbidity of spinal infections, emphasizing the importance of prompt diagnosis and appropriate management to prevent long-term sequelae.(9, 15)

Confirmatory diagnoses were established using a combination of histopathology, cytology, culture, biochemistry, and therapeutic outcomes. The high concordance rate (96.0%) between radiological and confirmatory diagnoses highlights the reliability of MRI in diagnosing tubercular spondylodiscitis. The sensitivity of MRI was found to be 96.4%, indicating its ability to accurately detect spinal infections, while the specificity was 89.0%, suggesting a low rate of false positives. The high sensitivity and specificity of MRI demonstrated in our study are consistent with previous research validating its efficacy in diagnosing spinal infections.(16) MRI's ability to visualize soft tissue abnormalities, including vertebral body destruction, paraspinal abscesses, and spinal cord compression, contributes to its diagnostic accuracy and aids in guiding appropriate therapeutic interventions.(17)

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Vertebral destruction, particularly at the endplate, was a prominent feature observed in 92.0% of the cases. This finding is consistent with the characteristic bony destruction seen in tubercular spondylodiscitis, reflecting the destructive nature of the infection.(18) The high sensitivity (100%) and moderate specificity (81.4%) of vertebral destruction underscore its importance as a reliable indicator of spinal infection, particularly when combined with other imaging findings. The presence of a paravertebral soft tissue shadow was identified in 80.0% of the cases, indicating soft tissue inflammation and abscess formation adjacent to the affected vertebrae. This finding correlates with the inflammatory response associated with spinal infections, including tubercular spondylodiscitis.(19) The high sensitivity (96.8%) and specificity (85.3%) of this parameter emphasize its diagnostic value in identifying spinal infections, supporting its inclusion in the diagnostic criteria. T2 hyperintense signal involving the intervertebral disc was observed in 96.0% of the cases, indicating discitis and associated inflammation. This finding is characteristic of infectious discitis, including tubercular involvement, and reflects the pathological changes within the intervertebral disc.(20) Although the sensitivity (80.6%) and specificity (82.4%) of this parameter are slightly lower compared to other features, it remains a valuable imaging marker for spinal infections, particularly when interpreted in conjunction with other MRI findings. Large paraspinal granulation tissue or abscess was present in 36.0% of the cases, highlighting the variable presentation of abscess formation in spinal infections.(21) While the sensitivity (72.2%) and specificity (67.5%) of this parameter are relatively lower compared to other features, the presence of paraspinal abscesses remains clinically significant, necessitating prompt intervention to prevent neurological complications and disease progression. Spinal deformity, in relation to the region of spine affected, was noted in 44.0% of the cases, reflecting the potential for structural changes and instability secondary to spinal infections. The high sensitivity (89.8%) but relatively lower specificity (64.3%) of this parameter highlight its diagnostic value in detecting spinal deformities associated with infectious aetiologies. However, caution is warranted in interpreting spinal deformities as a sole indicator of spinal infection, as they can also arise from other pathological processes.(22) Overall, the comprehensive evaluation of MRI parameters in our study underscores the diverse imaging manifestations of spinal infections, providing valuable insights into their diagnostic accuracy and clinical relevance. These findings support the pivotal role of MRI in the early detection, characterization, and management of spinal infections, facilitating timely interventions and improved patient outcomes.(23)

Despite the strengths of our study, including a well-defined patient population and comprehensive diagnostic evaluation, there are limitations that warrant consideration. The small sample size and single-centre design may limit the generalizability of our findings. Additionally, the retrospective nature of the study may introduce inherent biases and limitations in data collection and analysis.

Conclusion

In conclusion, our retrospective study provides valuable insights into the utility and accuracy of magnetic resonance imaging (MRI) in diagnosing spinal infections, with a specific focus on tubercular spondylodiscitis. The majority of patients were radiologically diagnosed with tubercular spondylitis based on MRI findings, highlighting the significance of MRI as a non-invasive imaging modality for early detection and characterization of spinal tuberculosis. Furthermore, various MRI parameters such as vertebral destruction, paravertebral soft tissue shadow, T2 hyperintense intervertebral disc, large paraspinal granulation tissue or abscess, and spinal deformity demonstrated high sensitivity and specificity, contributing to the diagnostic accuracy of MRI in identifying spinal infections. Confirmatory diagnoses, obtained through a combination of histopathology, cytology, culture, biochemistry, and therapeutic outcomes, reaffirmed the reliability of MRI findings in diagnosing tubercular spondylodiscitis, with a high concordance rate observed between radiological and confirmatory diagnoses. Overall, our study underscores the pivotal role of MRI in the comprehensive evaluation of spinal infections, facilitating timely diagnosis, appropriate management, and improved patient outcomes. Future research endeavours should focus on further validating the diagnostic accuracy of MRI in larger patient cohorts and exploring advanced imaging

techniques to enhance the early detection and characterization of spinal infections.

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Table 1: MRI parameters assessed in the present study

Parameter assessed	**Cases with positive findings**	**Standard sensitivity and specificity**
Vertebral destruction (particularly endplate)	23/25 92.0%	100% & 81.4%
Paravertebral soft tissue shadow	20/25 80.0%	96.8% & 85.3%
T2 hyperintense intervertebral disc	24/25 96.0%	80.6% & 82.4%
Large paraspinal granulation tissue or abscess	9/25 36.0%	72.2% & 67.5%
Spinal deformity (in relation to region of spine affected)	11/25 44.0%	89.8% & 64.3%

Figure 1: Spondylodiscitis of C5-C6, with anterior epidural abscess and significant dural reaction causing compression myelopathy

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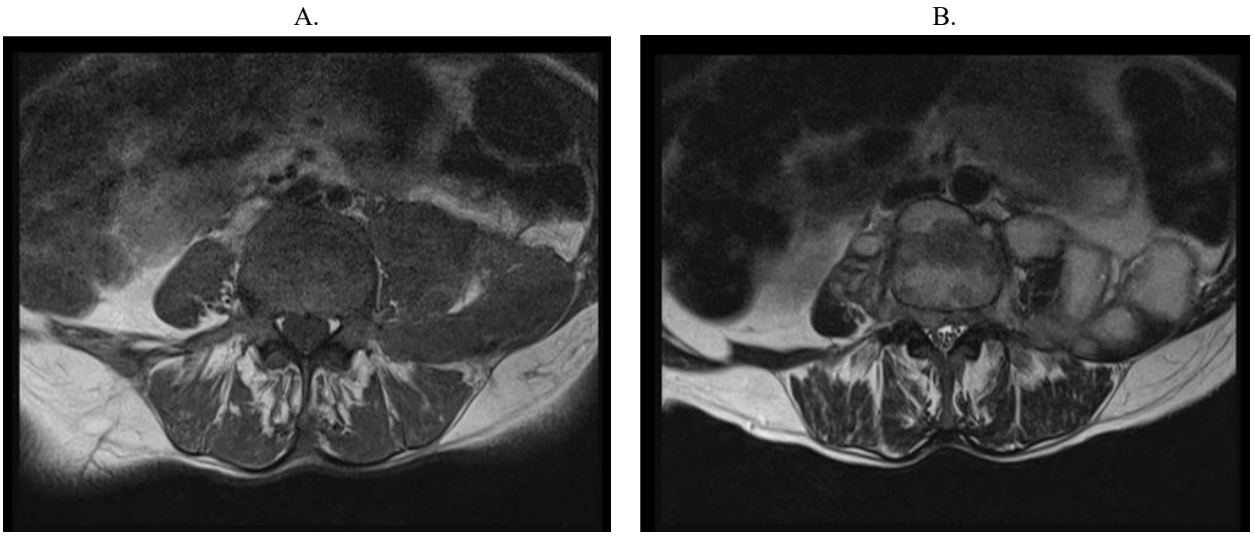

Figure 2: A. T1W image shows hypointense collection in left psoas muscle; B. T2W image shows hyperintense collection in prevertebral and bilateral paravertebral region extending into left psoas muscle. A small extradural component compressing the cord is also seen

Figure 3: Grade 4 destruction of the D8 vertebra, grade 3 destruction of the adjacent D7 vertebra, and grade 1 destruction of the D9 vertebra; additional features were gross kyphotic deformity (angular gibbus), resultant stretching and thinning of the cord but no signal change suggestive of cord atrophy, and fibrofatty proliferation along the dorsal epidural space appears hyperintense on both T1 and T2W *(from a known case of TB, on ATT since the past 4 months)*

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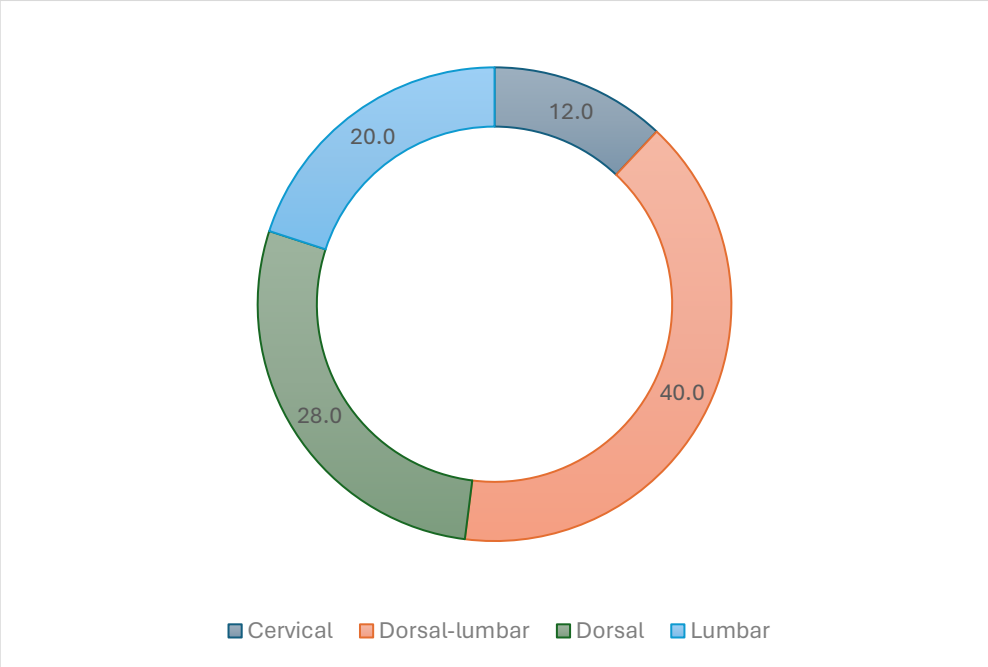

Figure 4: Distribution of patients, by site of spinal involvement

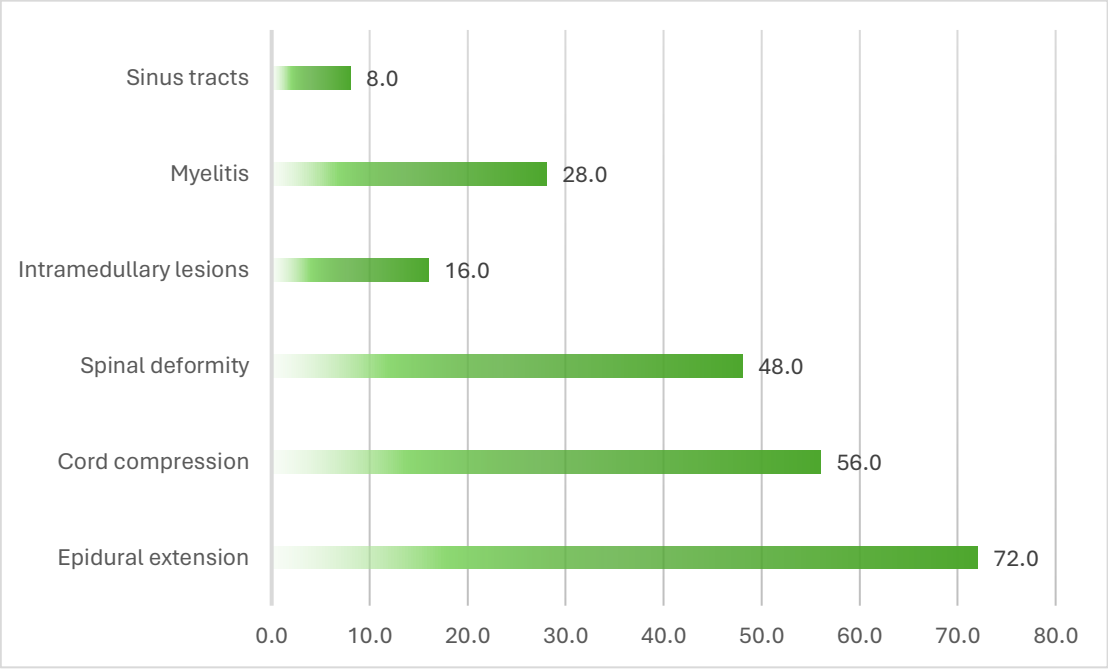

Figure 5: Distribution of patients, by complications